

March 25, 1960

Dear Gene:

Re: Project OX

The attached sheets briefly describe the design problem areas which will be investigated during the fabrication and testing of the non-flyable breadboard units. The non-flying breadboard has the primary function of proving an engineering concept. It allows the engineer the opportunity to fabricate models with known deviations from final form, often created specifically so that a particular element of the test may be more accurately monitored. Weldments are frequently substituted for castings. Non standard electronic components satisfactory for circuit check out are frequently used. Other measures of expediency are followed.

25X1A The proposal of 2 February 1960 contained an amount estimated at [] for the expenditures for and leading up to completion of non-flyable breadboards. This was made up as follows:

Item 1
Item 3
Item 4
Item 8

25X1A

This, however, is not an appropriate stopping point because the final photographic performance of the system can only be determined from actual flights as can compatibility with the vehicle.

25X1A As a second step, therefore, we propose a flyable test bed which would approach the expected final configuration as closely as possible. The additional amount provided in our previous estimate for this equipment is [] This is made up as follows:

Item 1
Item 3
Item 4
Item 5
Item 8

25X1A

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At this point we would like to again stress the desirability of having two (2) flying test beds instead of one. If you will compare our proposals of 19 January and 2 February, you will note that this second model will cost you only [] if done concurrently with the other work. It seems to us that this comparatively small expenditure provides a great deal. 25X1A

1. Two test beds would provide an opportunity to analyze each equipment and photographic results before having to reload and send out the unit for another test.
2. In event vehicle turn around time is short during the flight test program, it would be more certain that a test bed would be ready for subsequent test flight.
3. By operating the test schedule with two units rather than one, delays in modification of a single unit would not necessarily delay the flying of the second unit. In the early phases, a limited test would get partial information on each test flight. The test beds would not have to be identical until the latter phases of the test program.
4. Two units would not require additional ground support equipment or additional personnel.
5. In event of unforeseen malfunction or accident which leads to equipment damage (for instance, on landing) one unit would always be available. This consideration includes such factors as out of tolerance power or transients, operating altitude being in error, simple burnout of equipment.
6. The use of two units would provide an opportunity to return one unit to Rochester in event of emergency modification or overhaul without seriously affecting the test program.
7. In event a particular phase of the program was presenting operational checkout difficulties (such as sensor to stable platform control) one unit could be reserved for only this type of test until its completion.
8. One set of recording gear could be utilized with provisions for sensors or recorders to be permanently mounted in each of the beds.

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9. By using two test beds, statistical data are accumulated which verify design predictions rather than having one tuned for superior results or one which is inferior in performance.

ELG/MDG



E. L. G.

cc: JLB
ABS
BLE

Enclosure to
Letter - 3/25/60

The following is a summary breakdown of the fields of activity which must be exploited to execute the design and fabrication of the "Q" Bay equipment. Those items marked (*) would not be considered in the non-flyable breadboard phase.

The non-flyable prototype would be used in each case to determine the soundness of design concept and reliability of design execution.

Optical performance can be predicted to a high degree of accuracy. However, since optical imagery formation in conjunction with a photosensitive material is a complex factor, ultimate quality of the recorded information can only be evaluated by controlled testing under actual or simulated conditions of use. It is planned to fabricate and test in the laboratory, individually and as a working system, all of the optics in the recording system. This fabrication would include as a minimum all items of Section 1.0. Section 1.2, Mirror, will include testing of both the fixed and scan mirrors in the system. The test will be instrumented to check the scan cycle for any perturbations which would result in image loss. The test hardware may in no way resemble the final item but must prove the principles for which it was designed. In addition to design configuration, information as to the resolution, sine wave response and tone transfer characteristics of the overall system will be checked.

It is certain that a mock-up of the cooled portion of the camera will have to be fabricated to test the thermal design. The mock up will also be used to measure performance under the predicted environment of the film drum or transport, the film supply and take-up drive, the mirror drive, the double walled enclosure which will maintain the film at required operating parameters, and other electro-mechanical functions such as exposure slit aperture control.

Ability of the "Q" bay stable platform to satisfy the requirements of the flight profile and aircraft excursions can be checked by laboratory tests. The stable platform test and instrumentation includes testing of the gymbal mount, the attitude correction linear solenoids and the gyro references, and vehicle attitude sensors such as V/H and yaw. Power dissipation and duty cycle of the stable platform drivers is an important factor in the "Q" bay overall environmental thermal design.

The circuitry for the camera can be initially constructed on a strictly breadboard basis to verify control circuit design. The final circuit selected will have to consider the use of high

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temperature transistors and components to minimize cooling requirements. The control circuitry for the camera will establish cycling rate, will drive and synchronize the IMC correction, will convert flight data into a recordable form and sequence it to the data recording head. An automatic caging system which has the capability of locking and unlocking the stable platform must be proven to account for abnormal aircraft flight characteristics. Other programmed functions such as exposure changes must be made by the control electronics.

The automatic focus control principle planned for the instrumentation can be checked out by relatively simple breadboard tests. The final sensor electronics and drive system need not be used, however, circuit parameters which can be obtained under operating conditions of temperature and pressure must be observed.

Breadboarding of the data system involves not only the mechanism to record the data but also considerations as to how that data will be interpreted by the ultimate film user. Bulk of recording equipment will be determined during the early test program. The choice of using only digital information, or only numeric, or a combination of both must be made. In addition to navigational data, the recording mechanism for the film frame timing marks or clock pulse, as well as system axis fiducial mark, must be determined.

Breadboarding the film might seem to be a nebulous objective. We have, however, several critical tests to perform. Handling through the camera breadboard mechanism, need for anti-halation backing, modification of existing films in respect to speed and spectral response characteristics, effect, if any, on sensitometry of maintaining film at the instrument bay environment, development technique, operation of the film after soaking at a low temperature (so that the film may be used to cool the camera mechanism), prevalence of static in the mechanism transport all are in areas in which parameters may be determined by simulating flight conditions. Determination of an adequate spool for camera and shipping use must be accomplished.

The choice of instrumentation for horizon determination has been deferred until a more firm "Q" bay configuration is established. The horizon camera will either be mounted to photograph through the bay window or through ports in the upper portion of the bay. Tests will indicate the feasibility and attained accuracy of both systems.

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The requirements of the temperature and pressure environments will not be the prime purpose of the non-flyable test bed. Effects on components of the system will be individually checked and in many cases calculations from the test data will yield the design parameters. Effects of power variations and transients will be measured. Measurements and the study of the effect on the thermal design of electronic and electrical dissipation will be performed.

The non-flyable breadboard units would serve to verify the functional capabilities of the design. Data obtained from these units will be carried forward to the execution of the flyable prototype model.

The flyable test bed must consider all items in the project breakdown in as final a form as is possible. Unknown parameters which cannot be simulated in a laboratory must be determined during the flight test program.

For instance, the areas of laminar flow around the vehicle can be in part calculated. Exact information, is however, necessary for the prediction of such items as V/H accuracy. We are aware of the fact that the layer between the shock wave and the skin layer is a wedge shaped one. We also know that this layer must be scanned through a finite sweep angle. Test data will indicate whether or not a correction can be or must be made because of the refractive errors contributed by this layer.

Optical performance cannot be completely predicted by theoretical calculation. The effect of photographing through thermal and pressure boundaries may be significant. Turbulence in the various layers must be determined by actual tests. The overall integrated performance of the photographic system to produce a high acuity record usable to the photo interpreter may only be judged by studying that record.

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E. L. G.

Project Breakdown "Q" Bay Equipment

- 1.0 Optics
 - 1.1 Lens
 - 1.2 Mirror
 - 1.3 Window
 - 1.4 Filter
 - 1.5 Field Flatteners
 - 1.5.1 Pressure Window
- 2.0 Camera Body
 - 2.1 Film Transport
 - 2.2 Mirror Drive
 - 2.3 Enclosure
 - 2.4 Support Frame
 - 2.5 Slit Drive
- 3.0 Stable Platform
 - *3.1 Aircraft Attachment
 - 3.2 Stabilizer
 - 3.3 Isolator
 - 3.4 V/H and Yaw Detector
 - 3.5 Caging
- 4.0 Programmer
 - 4.1 Cycling
 - 4.2 IMC Control
 - 4.3 Data Control (converter)
 - *4.4 Altitude
 - 4.5 Caging Control
 - 4.6 Exposure Control
- 5.0 Automatic Focus
 - 5.1 Sensor
 - 5.2 Drive
- 6.0 Data System
 - 6.1 Display
 - 6.2 Recording Optics
- 7.0 Film
 - 7.1 Spool (shipping and use)
 - 7.2 Emulsion Spec.
- *8.0 Field Support
 - *8.1 Field Test Equip.
 - *8.2 Ground Handling
 - *8.3 Field Shop and Service
 - *8.4 Shipping Containers (spec.)
 - *8.5 Spares

Project Breakdown "Q" Bay Equipment (Continued)

- 9.0 Horizon Recording
 - 10.0 Requirements
 - 10.1 Environment - temp., pressure
 - *10.2 System Performance
 - 10.3 Power
 - *10.4 Weight
 - *10.5 "Q" Bay Space
 - *10.6 Electrical Connections
 - 10.7 Cooling
 - *10.8 Window Hatch
 - *10.9 Helium Supply and Control
 - *11.0 Performance Tests (In plant)
 - *11.1 Environmental Test Equipment & Procedure
 - *11.2 Photographic Test Equipment & Procedure
 - *11.3 Design Improvements
- *12 Field Test Evaluation